The radio continuum structure of bright galaxies at 1.4 GHZ.

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CHAPTER VIII. SUMMARY

In the preceding Chapters a large number of observational facts were presented. These are extensively summarized in Chapter IV-4i, V-2e, VI-4e and VII-3e. Here we will summarize and consolidate the more general conclusions from the entire radio continuum survey.

a. The extended non-disk emission

The (double) source structure of the radio continuum emission of the more powerful radio sources associated with galaxies is only briefly discussed in Chapter VI. In Chapter VII we gave a fractional luminosity function for these sources. Some evidence is presented that it is not the lack of gas in elliptical and lenticular galaxies which causes the occurrence of the double source structure in these galaxies. The results indicate that the mass of an elliptical or of the bulge component of a lenticular determine whether these galaxies manage to have strong radio continuum emission with a double lobed structure.

b. Disk emission

This radio component is extensively discussed in Chapter IV, V and VI. The radio continuum emission is mainly non-thermal (synchrotron mechanism) and depends on the density of relativistic electrons and on the magnetic field strength. From the present study we have been able to draw the following conclusions about where most of the sources of relativistic electrons are situated and the influence of the gas content on the magnetic field strength.

No major differences were found in the disk emission of spirals which have a companion and isolated spirals, of barred spiral galaxies and non-barred spirals and of spirals of different luminosity class and colour. This clearly suggests that, in general, the density waves have hardly any direct influence on the radio continuum emission and that the young spiral arm population is not the main source of relativistic electrons. The latter is also shown by the direct proportionality between the radio power of the disk component and the optical luminosity.

The role of the supernovae of type I, which do not belong to the extreme young population, is still unclear although the change of disk emissivity with morphological stage is not consistent with these supernovae being the only sources of relativistic electrons. The main unknown here is the possible change of magnetic field strength with morphological stage.

Central sources as the main producer of the relativistic electrons in the disk component are ruled out.

Consequently we are led to the conclusion that the main sources of relativistic electrons belong to the older disk population and that the supernovae of type I are probably not the main sources. Possible alternative sources are pulsars and flare stars and also stochastic acceleration mechanisms may play a role. In individual cases, however, the spiral arm radio continuum emission may dominate the emission of the disk.

The influence of the gas density on the magnetic field strength in disks of galaxies is suggested by the comparison of the disk emissivity in lenticulars and spiral galaxies. The low gas content of the lenticulars possibly causes the low disk emissivity in these galaxies because there is insufficient gas to confine a strong magnetic field in these galaxies.

c. <u>The central source</u>

The radio continuum central sources (size <20") of galaxies are discussed in Chapter IV, V and VI. A comparison of the central sources (including the flat spectrum nuclear sources) of ellipticals, lenticulars and spirals is given in Chapter VI.

The central sources present in ellipticals and lenticulars are mainly flat spectrum nuclear sources (see below) indicative of the influence of gas on the steep spectrum component of the central sources. If there is hardly any gas in the central region then there is no steep spectrum central source. The influence of the gas is also strongly suggested by the observation that barred spirals have stronger central sources than non-barred spirals and that central sources of spirals with a companion are stronger than those in isolated spirals. In barred spirals the enhanced emission may be caused by the large non-circular motions of the gas and the effects caused by this (i.e. shocks) while in interacting galaxies gas might be dumped into the central region giving rise to a higher activity there.

It is hard to see how the gas (kinematics or content) can explain the stronger central sources in early-type spirals compared to those in the late-type spirals. The decrease of radio power of the central source with morphological stage is possibly due to the decrease of the central density with morphological type. This gives rise to a lower density of surces of relativistic electrons and possibly to weaker magnetic fields in the central region of the late-type spirals.

We can conclude that the density in the central region is one of the more important parameters which determine the strength of the central source. They are probably also severely influenced by the kinematics and density of the gas in the central region.

d. The nuclear source

The flat spectrum nuclear sources are discussed in Chapter VI and VII. Most of the central sources of elliptical and lenticular galaxies belong to this class of objects. Only few spiral galaxies have (detectable) nuclear sources. However, in spirals they can easily be hidden by the dominating steep spectrum component of the central source or be attenuated by free-free absorption.

The comparison of the nuclear sources in elliptical and lenticular galaxies shows that the radio power of the nuclear sources is related to the mass of the bulge component of these galaxies. It might also be related to a difference in the kinematics of the bulge component in lenticulars and of the ellipticals. However, such differences in kinematics are still not well established.

A further important parameter which determines the radio power of the nuclear source is the infall rate of gas. The data on the ellipticals suggest that only if the gas removal mechanisms are less efficient, there is enough gas present to fuel the nuclear source.

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